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EFFECT OF COLD WEATHER ON MOTOR VEHICLE EMISSIONS. 1974.

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# Effect of Cold Weather on Motor Vehicle Emissions



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Report EPS 4-AP-74-1

Air Pollution

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June 1974

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EFFECT OF COLD WEATHER ON MOTOR  
VEHICLE EMISSIONS

by

J. C. Polak

Emission Testing Laboratory  
Technology Development Branch  
Air Pollution Control Directorate

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# ABSTRACT

In November 1972 the Emission Testing Laboratory of the Air Pollution Control Directorate, Environment Canada, initiated a program to resolve the effect of cold ambient temperatures on exhaust emissions. A fleet of five vehicles was chosen and three types of emission tests were done: cold start, cold start with block heater operational, and cold start with extended idle. The results of the tests indicated that hydrocarbon and carbon monoxide emissions increased substantially on cold-start tests as temperatures decreased. The use of block heaters, however, tends to negate this effect, but the practice of allowing an engine to idle after a cold start increases the total emissions.

## RÉSUMÉ

En novembre 1972, le laboratoire d'essais sur les émissions de la Direction générale de la pollution de l'air à Environnement Canada entreprenait un programme visant à résoudre le problème des effets du froid sur les émanations des véhicules automobiles. On a choisi un parc de cinq véhicules, et trois types d'essais sur les émissions ont été menés: démarrage à froid, démarrage à froid avec chauffe-bloc et démarrage à froid avec ralenti prolongé. Les résultats des essais montrent que les émanations d'hydrocarbures et de monoxyde de carbone augmentent considérablement durant les démarrages à froid lorsque la température baisse. Toutefois, l'emploi d'un chauffe-bloc tend à annuler cet effet, mais si on fait tourner le moteur au ralenti après un démarrage à froid, il y a augmentation des émissions globales.

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1

INTRODUCTION

It has been stated that exhaust emission standards specifically designed to achieve an acceptable air quality in Los Angeles may not necessarily apply in all parts of Canada where modes of operation in urban driving and climatic conditions differ vastly from those in the United States. The effectiveness and durability of certain emission control devices under Canadian winter temperatures and road conditions have also been questioned (1). Because insufficient test data (2) were available to resolve these questions, high priority was assigned to determining the effects of the Canadian climate on exhaust emissions and emission control systems. This report presents results obtained during the first year of cold weather testing by the Department of the Environment.

Previous research has indicated that exhaust emissions from light duty motor vehicles increase as ambient soak temperatures decrease (3, 4). This observation is supported by two facts. First, the thickness of the quench layer, produced during operation of an internal combustion spark-ignited piston engine, increases as cylinder wall temperatures decrease (3); when this quench layer is thick, the amount of unburned fuel in the exhaust is high. Secondly, choke operation time also increases as initial temperature decreases (4). Therefore, when the initial engine temperature is low, the vehicle is subjected to a rich fuel-air mixture until the choke opens. Both these effects are accentuated by low ambient temperatures, and exhaust emissions are expected to increase with decreasing ambient temperatures.

To ensure compatibility of the test data with that obtained in the United States, compliance monitoring in Canada is performed under conditions similar to those used in the United States. The test run is a 23-min, 7.5-mile driving cycle designed to represent a typical North American commuter trip involving a series of nonrepetitive idles, accelerations, cruises, and decelerations. The temperature range in which exhaust emission tests are performed is 68-86 °F.



Because vehicle operation is not in a steady mode over the test cycle, the exhaust emission rate varies as the coolant temperature changes, and as the choke position and fuel consumption rate vary. The initial few minutes of the driving cycle produce characteristically high emission rates; during the winter months initial coolant temperatures are low and the choke is closed, which aggravate this effect. Because some Canadian drivers allow their engines to idle briefly before driving their vehicles in cold weather and frequently use engine coolant (block) heaters during the winter months, the following series of tests were conducted after a 12 h exposure to cold outdoor temperatures:

- (1) cold start - 7.5-mile 23-min driving cycle,
- (2) block heater (engine coolant heater) - 7.5-mile 23-min driving cycle conducted after outdoor exposure during which the heater was operational,
- (3) idle - varying extended idling periods followed by 7.5-mile 23-min driving cycle.

The testing of a fleet of five late-model light-duty motor vehicles began in November 1972 and continued until late spring, 1973. This test period yielded results over a temperature range of -2 to 72 °F.

## 2 EQUIPMENT

### 2.1 Emission Testing Equipment

The emission testing equipment used for this project is described in References 5 and 6. It is the same as that used in emission testing of motor vehicles for compliance with emission standards.

### 2.2 Auxiliary Equipment

To obtain test data under cold ambient conditions, a roll-away door was installed in an outside wall to permit direct access to an insulated test cell constructed against this wall. When a test vehicle was placed in the test cell with the door open, the engine compartment was exposed to the outside ambient air and, at the same time, insulated from the inside air by means of a heavy curtain fitted



around the vehicle immediately in front of the windshield. The remainder of the vehicle and the chassis dynamometer were behind the shed and not subject to cold conditions.

A multi-point temperature recorder with thermocouples was used to monitor temperatures outside and inside the shed as well as intake air, engine coolant, and oil temperatures.

### 2.3 Test Vehicles

Seven vehicles were initially chosen to represent a typical Canadian fleet; later two of these vehicles were dropped from the project, one because of consistent carburetor problems and the other because its air-cooled rear engine was incompatible with the test configuration. The five test vehicles were:

- (1) 1973 Toyota Corolla, 97.6 in.<sup>3</sup>, four cylinders, four-speed manual transmission;
- (2) 1973 Ford Torino, 302 in.<sup>3</sup>, V8, three-speed automatic transmission, power steering, power brakes;
- (3) 1973 Chevrolet Vega, 140.3 in.<sup>3</sup>, four cylinders, three-speed manual transmission;
- (4) 1973 Plymouth Satellite, 318 in.<sup>3</sup>, three-speed automatic transmission, power steering, power brakes;
- (5) 1972 Chevrolet Belair, 350 in.<sup>3</sup>, three-speed automatic transmission, power steering, power brakes, V8.

## 3 PROCEDURE

### 3.1 Test Preparation

The vehicles were parked outside overnight near the roll-away door and exposed to ambient climatic conditions for a 12-16 h period. The roll-away door remained closed.

At test time, the chassis dynamometer was preconditioned to match the inertia and road load horsepower of the vehicle to be tested. The roll-away door was then opened and the test vehicle pushed into the cold shed and onto the dynamometer. Cooling fans were placed in front

of the test vehicle, directing air flow into the radiator and engine compartment and thermocouples were installed in the engine to monitor coolant, intake air, and oil temperatures. The insulated curtain was then dropped around the vehicle. Outside ambient temperatures and shed temperatures were measured and when the two were approximately equal, the test was started.

### 3.2 Test Method

3.2.1 Cold-Start Tests. The vehicles were tested from a cold start; start-up and operation over the 23-min driving cycle made one complete test run. Each test consisted of a 23-min driving cycle, with exhaust sampling and analysis of the collected sample. This procedure is described in References 5 and 6.

3.2.2 Block Heater Tests. The procedure used for this series of tests is identical to that outlined in Reference 5 and 6. During the soak period, however, the block heaters were used. Two vehicles were used in this test series: 1972 Chevrolet and 1973 Vega.

3.2.3 Idle Tests. Two separate emission tests were conducted. The vehicle, after being soaked outside overnight, was pushed onto the dynamometer and the engine started. It was then allowed to idle freely for 2, 5 or 15 min, while HC (hydrocarbon) and CO (carbon monoxide) were monitored on a continuous basis. Immediately after idling, a regular 23-min emission test was conducted.

### 3.3 Data Analysis

The HC, CO, and NO<sub>x</sub> (oxides of nitrogen) concentrations from the 23-min emission tests were converted to units of grams per mile by the formulas shown in References 5 and 6.

3.3.1 Cold-Start Tests. Test results were collected for each vehicle and curves were drawn for the emissions of each pollutant from each vehicle over a temperature range of -10 to 80 °F. Linear curves normally yielded better correlation than did parabolic ones.

To avoid weighting the average vehicle emission curves incorrectly, a zero deviation point of 60 °F was used for each vehicle, with percentage deviations above or below this point forming the ordinate



of the Emissions versus Temperature curves. This process resulted in five linear functions per pollutant and simple arithmetic averaging was used to obtain an average vehicle exhaust emission curve for each of the three pollutants.

3.3.2 Block Heater Tests. Correlation linear curves were derived from test results for each car.

3.3.3. Idle Tests. During idling, emissions were measured continuously to yield an irregular curve over the testing period. An average value of the emission concentration was derived by integrating the area under this curve with respect to time. To convert this value to a weight of pollutant emitted during idling, the following calculation was made:

$$G = \frac{528}{760} \times \frac{P}{T} \times d \times C \times V \times R \times t$$

where

G - weight of pollutant, g  
P - pressure, ml Hg  
T - sample temperature, °R  
d - density of pollutant, g/ft<sup>3</sup>  
C - volume concentration of pollutant  
V - pump capacity, ft<sup>3</sup>/rev  
R - pumping speed, rpm  
t - time, min

The total weight of pollutant emitted is obtained by adding the weight of pollutant emitted during idling to that emitted during the following 23-min test.

#### 3.4 Vehicle Maintenance

The maintenance done on the test vehicles over the testing period is described in Table 1. The fuel used for the cold weather testing program was regular winter-grade gasoline, with a minimum octane number of 90, purchased from a local service station.

## 4 RESULTS

### 4.1 General

Tables 2 to 11 give the cold-start and baseline emission

test results for the five vehicles used in this program. Table 12 shows the block heater series results for the two vehicles used. Tables 13, 14, and 15 list the idle test results for the three vehicles used.

Figures 1, 2, and 3 show graphically HC, CO, and NO<sub>x</sub> exhaust emissions plotted against coolant temperature at start-up for each vehicle in the cold-start program. The average vehicle emission curves are also shown. Figures 4, 5, and 6 show the HC, CO, and NO<sub>x</sub> exhaust emissions plotted against temperature both with and without block heaters. Figures 7 and 8 show total emissions versus the initial temperature of the engine coolant at the start of the test. Figure 9 shows NO<sub>x</sub> emissions plotted against this temperature. Shown on these same figures for comparison are the average vehicle emission curves derived from the series of cold-start tests. Figures 10 and 11 show HC and CO emissions from the 23-min test plotted against the idling time. Figure 12 is a plot of idle time versus engine coolant temperature and HC and CO emissions.

#### 4.2 Discussion of Results

4.2.1 Cold-Start Test Emissions. Figure 1 is a graphic display of hydrocarbon (HC) emissions against engine coolant temperature at start-up. The five vehicle curves are labelled 1 to 5 and are shown as percentage deviations from the HC emissions at 60 °F. The average HC emissions for the five vehicles is represented by:

$$P_{HC} = 115 - 1.91T$$

where  $P_{HC}$  is percentage deviation of hydrocarbon emissions and T is temperature in degrees fahrenheit. Based on these data, the average vehicle HC emissions will increase by 100% at 8 °F when compared with emissions at 60 °F.

Figure 2 is a graph of CO emissions against engine coolant temperatures at start-up. The five vehicle curves are labelled 1 to 5 and are shown as percentage deviations from the CO emissions at 60 °F. The average vehicle curve function is:

$$P_{CO} = 151 - 2.53T$$

where  $P_{CO}$  is percentage deviation of carbon monoxide emissions and T is



temperature in degrees fahrenheit. Using this function, the average vehicle CO emissions will be double the 60 °F value at 20 °F.

Figure 3 is a graph of NO<sub>x</sub> emissions against engine coolant temperature at start-up. The average vehicle NO<sub>x</sub> curve is described by the function:

$$P_{NO_x} = -1.8 + 0.030T$$

where  $P_{NO_x}$  is percentage deviation of oxides of nitrogen emissions and T is temperature in degrees fahrenheit. This curve has little slope since NO<sub>x</sub> production is a function of combustion temperature and is not directly affected by fuel vaporization, choke position, or wall quenching, which are the parameters that affect HC and CO emissions.

In reviewing the data from Table 4, the emission values for vehicle 2 are found to be high in HC and CO at the lower temperatures and low in NO<sub>x</sub>, which results in unusually steep slopes on the percentage deviation curves of Figures 1, 2, and 3. This pattern is probably caused by rich operating conditions in the carburetor. Rich carburetor operation could be caused by improper choke setting, idle setting, enlarged jets, or a combination of these. However, the HC, CO, and NO<sub>x</sub> curves in Figures 1, 2, and 3 for vehicle 2 should flatten out as leaner operating conditions are realized, which would lower slightly the average HC and CO curves of Figures 1 and 2 while increasing slightly the average NO<sub>x</sub> curve of Figure 3.

Vehicle 4 (Plymouth Satellite) was equipped with a temperature override device (defeat device), which modulates the exhaust gas recirculation (E.G.R.) valve and the spark-delay valve when ambient temperatures drop below that at which the device is set. This override device adversely affects NO<sub>x</sub> emissions at temperatures below the setting on the device. Removal of the defeat device from a vehicle should cause the NO<sub>x</sub> curve to flatten out; however, since these devices were included on some 1973 vehicles, no correction of the average vehicle curves is warranted. More information on this phenomenon may be obtained from the Air Pollution Control Directorate, Environment Canada.

The curves of emissions versus temperature are shown as linear functions, and these are accurate estimations over a limited temperature range. HC and CO emissions are expected to rise faster at temperatures outside this limited range to give a quadratic curve over the wider temperature range. Therefore, the curves shown in Figures 1 and 2 are more accurate between 0 and 70<sup>0</sup> than at extreme temperatures.

Emission data shown in Tables 2 to 11 show some scattering. The amount of scatter, however, is well within experimental limits when consideration is given to the number of parameters involved.

4.2.2 Block Heater Test Emissions. Although only two vehicles were tested to determine the effect of coolant heaters on emissions and only a minimal number of tests were conducted, it is apparent from Table 12 that engine coolant temperatures were consistently above the ambient temperature at the end of a soak period. The 1973 Vega had a radiator hose in-line heater whereas the 1972 Chevrolet had an in-block heater. Lower coolant temperatures recorded for the Vega can be attributed to the Vega's in-line heater and aluminum block. The results show that the 1972 Chevrolet emission differential (with and without heater) is larger than that of the Vega (Figures 4 and 5). This result suggests that HC and CO emissions depend on the engine coolant temperature and decrease as engine coolant temperature increases.

4.2.3 Idle Test Emissions. Figures 7 and 8 graphically display total emissions (HC and CO) versus the initial engine coolant temperature at the start of the test. Figure 9 shows NO<sub>x</sub> emissions plotted against temperature. Shown on these same figures for comparisons are average vehicle emission curves derived from the cold-start tests. In Figures 7 and 8, the data points for the Vega are consistently below the average vehicle curve. This phenomenon is a result of low emission curves for the Vega, which are shown in Figures 7 and 8 as dashed lines. No continuous monitoring was done for NO<sub>x</sub> during idling but the NO<sub>x</sub> values in Figure 9 should be higher.

Figures 10 and 11 show HC and CO test emissions, respectively, plotted against the length of idling time before the 23-min test. It is evident from these graphs that increasing idling times promotes a



diminishing 23-min test emission. The data points were at different temperatures (see Tables 2, 3, and 4) and no distinction was made regarding vehicle type. The greatest temperature effect occurs at the minimum idling time.

Figure 12 is a plot of idling time versus engine coolant temperature, HC emissions, and CO emissions. Vehicle type is not shown since these curves are generally representative of most cars. By the time the coolant temperature had stabilized (thermostat open), the HC and CO emissions had reached a minimum value. This trend explains the phenomenon of Figures 10 and 11: as the idling period increases, coolant temperatures increase until the thermostat opens and emissions approach a low stable level. The initial idling period yields excessive and unstable emission levels (Figure 12).

It should be noted that only a limited number of tests were completed for each vehicle. Since inherent vehicle parameters affect emissions and only limited data were available, no characteristic curves have been drawn. The data will only yield broad generalizations at this time.

## 5 CONCLUSIONS

- (1) Results of the 1972-1973 cold weather program confirm that HC and CO exhaust emissions increase substantially with decreasing ambient temperatures, and that these increases are in excess of 100% when temperatures drop from 60 °F to 0 °F.
- (2) Engine coolant heaters substantially reduce the effect of cold weather on emissions.
- (3) The practice of idling a vehicle after a cold start before driving away creates more total emissions than does driving the car immediately after starting.

## 6 FUTURE WORK

Further cold weather testing is required including the



evaluation of a larger test fleet to confirm the results of this initial study as well as to assess the effect of age deterioration on emissions.

Before any further cold weather testing is carried out, the test facility and procedures should be improved by identifying and controlling as far as possible all of the variables that are pertinent to emissions during cold climatic conditions.

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TABLE 1 VEHICLE MAINTENANCE PROGRAM DURING TESTING

| Vehicle                    | Date<br>(month-day-year) | Mileage | Maintenance                                                                              |
|----------------------------|--------------------------|---------|------------------------------------------------------------------------------------------|
| 1973 Toyota<br>Corolla     | 01-13-73                 | 11      | -                                                                                        |
|                            | 03-07-73                 | 2057    | Change oil and filter                                                                    |
|                            | 05-04-73                 | 7214    | Change oil and filter, grease job                                                        |
|                            | 05-09-73                 | 7437    | Change plugs, points, and condenser;<br>adjust timing and idle                           |
|                            | 05-25-73                 | 8275    | -                                                                                        |
| 1973 Ford<br>Torino        | 10-23-72                 | 25      | -                                                                                        |
|                            | 11-06-72                 | 1565    | Change oil and filter                                                                    |
|                            | 11-22-72                 | 2077    | Change oil and filter                                                                    |
|                            | 05-03-73                 | 10224   | Change oil and filter, grease job,<br>replace plugs and high tension wires               |
|                            | 05-22-73                 | 10935   | -                                                                                        |
| 1973 Vega                  | 10-26-72                 | 54      | -                                                                                        |
|                            | 11-28-72                 | 1458    | Replace points and condenser, adjust<br>timing and idle                                  |
|                            | 05-03-73                 | 7713    | Change oil and filter, grease job                                                        |
|                            | 05-18-73                 | 8400    | -                                                                                        |
| 1973 Plymouth<br>Satellite | 10-30-72                 | 214     | -                                                                                        |
|                            | 11-09-72                 | 1300    | Change oil and filter                                                                    |
|                            | 01-08-73                 | 5170    | Change oil and filter, grease job                                                        |
|                            | 03-13-73                 | 8513    | Replace plugs, points, and condenser;<br>adjust timing and idle                          |
|                            | 05-04-73                 | 12540   | Change oil and filter, grease job                                                        |
|                            | 06-06-73                 | 14250   | -                                                                                        |
| 1972 Chevrolet<br>Belair   | 11-08-73                 | 10476   | -                                                                                        |
|                            | 02-12-73                 | 17218   | Change plugs, points, and condenser;<br>adjust timing and idle; change oil and<br>filter |
|                            | 05-03-73                 | 23482   | Valve job, change oil and filter,<br>grease job                                          |
|                            | 06-08-73                 | 24919   | -                                                                                        |



TABLE 2 COLD WEATHER EXHAUST EMISSIONS-1973 TOYOTA COROLLA

| Date<br>(month-day-year) | Initial engine coolant<br>temperature ( <sup>o</sup> F) | Emissions (g/mile) |    |                 |
|--------------------------|---------------------------------------------------------|--------------------|----|-----------------|
|                          |                                                         | HC                 | CO | NO <sub>x</sub> |
| 02-02-73                 | 32                                                      | 3.3                | 50 | 1.2             |
| 02-03-73                 | 25                                                      | 2.4                | 35 | 1.7             |
| 02-07-73                 | 28                                                      | 2.8                | 42 | 1.3             |
| 02-12-73                 | 4                                                       | 5.3                | 50 | 1.0             |
| 02-15-73                 | 28                                                      | 3.2                | 37 | 1.3             |
| 02-28-73                 | 20                                                      | 3.2                | 41 | 1.4             |
| 03-05-73                 | 36                                                      | 2.7                | 39 | 2.1             |
| 03-06-73                 | 35                                                      | 2.6                | 38 | 1.7             |
| 03-09-73                 | 36                                                      | 2.4                | 30 | 2.0             |
| 03-13-73                 | 47                                                      | 2.3                | 28 | 1.9             |
| 03-15-73                 | 38                                                      | 2.8                | 34 | 1.6             |
| 03-20-73                 | 30                                                      | 2.3                | 34 | 2.0             |
| 03-21-73                 | 35                                                      | 2.3                | 32 | 1.3             |
| 03-30-73                 | 54                                                      | 2.4                | 28 | 1.2             |
| 04-04-73                 | 42                                                      | 3.9                | 36 | 1.3             |
| 04-19-73                 | 61                                                      | 2.4                | 18 | 1.6             |
| 04-26-73                 | 49                                                      | 2.6                | 25 | 2.3             |
| 05-01-73                 | 32                                                      | 2.9                | 36 | 1.9             |
| 05-02-73                 | 52                                                      | 2.5                | 26 | 2.0             |
| 05-03-73                 | 62                                                      | 2.5                | 21 | 1.9             |
| 05-04-73                 | 44                                                      | 3.6                | 33 | 1.7             |
| 05-08-73                 | 50                                                      | 2.8                | 21 | 1.7             |
| 05-09-73                 | 60                                                      | 3.4                | 29 | 1.4             |
| 05-10-73                 | 72                                                      | 2.0                | 14 | 1.0             |
| 05-15-73                 | 50                                                      | 2.7                | 23 | 2.1             |
| 05-17-73                 | 46                                                      | 3.3                | 30 | 1.6             |
| 05-18-73                 | 44                                                      | 3.2                | 30 | 1.5             |
| 05-25-73                 | 68                                                      | 2.3                | 18 | 1.8             |

TABLE 3 BASELINE EXHAUST EMISSIONS-1973 TOYOTA COROLLA

| Date<br>(month-day-year) | Initial engine coolant<br>temperature ( <sup>o</sup> F) | Emissions (g/mile) |    |                 |
|--------------------------|---------------------------------------------------------|--------------------|----|-----------------|
|                          |                                                         | HC                 | CO | NO <sub>x</sub> |
| 01-13-73                 | 66                                                      | 2.5                | 32 | 1.1             |
| 01-15-73                 | 80                                                      | 2.5                | 24 | 1.4             |
| 02-05-73                 | 71                                                      | 1.4                | 13 | 1.1             |
| 02-08-73                 | 74                                                      | 1.1                | 12 | 1.1             |
| 02-14-73                 | 66                                                      | 2.0                | 16 | 1.6             |
| 02-16-73                 | 62                                                      | 1.6                | 15 | 1.8             |
| 02-17-73                 | 72                                                      | 1.5                | 13 | 1.6             |
| 02-22-73                 | 74                                                      | 1.6                | 16 | 1.0             |
| 02-26-73                 | 71                                                      | 2.0                | 20 | 1.3             |
| 03-07-73                 | 70                                                      | 1.8                | 17 | 1.8             |
| 03-08-73                 | 80                                                      | 2.0                | 18 | 2.2             |
| 03-12-73                 | 71                                                      | 2.2                | 21 | 1.8             |
| 03-14-73                 | 68                                                      | 1.7                | 16 | 1.6             |
| 03-22-73                 | 78                                                      | 1.7                | 15 | 1.6             |
| 03-23-73                 | 72                                                      | 1.5                | 13 | 1.5             |
| 03-28-73                 | 76                                                      | 1.8                | 14 | 1.0             |
| 03-29-73                 | 70                                                      | 2.1                | 15 | 0.9             |
| 04-18-73                 | 76                                                      | 2.0                | 14 | 1.6             |
| 04-24-73                 | 64                                                      | 2.4                | 23 | 1.7             |
| 04-25-73                 | 76                                                      | 2.2                | 22 | 2.2             |
| 04-30-73                 | 77                                                      | 2.1                | 15 | 1.9             |
| 05-07-73                 | 70                                                      | 2.0                | 12 | 1.6             |
| 05-11-73                 | 74                                                      | 2.4                | 21 | 1.3             |
| 05-14-73                 | 72                                                      | 3.1                | 19 | 2.2             |

TABLE 4 COLD WEATHER EXHAUST EMISSIONS-1973 FORD TORINO

| Date<br>(month-day-year) | Initial engine coolant<br>temperature ( <sup>o</sup> F) | Emissions (g/mile) |     |                 |
|--------------------------|---------------------------------------------------------|--------------------|-----|-----------------|
|                          |                                                         | HC                 | CO  | NO <sub>x</sub> |
| 11-10-72                 | 35                                                      | 4.6                | 141 | 0.1             |
| 11-13-72                 | 43                                                      | 3.3                | 88  | 0.1             |
| 11-14-72                 | 28                                                      | 5.1                | 154 | 0.2             |
| 11-17-72                 | 22                                                      | 5.9                | 169 | 0.7             |
| 11-21-72                 | 27                                                      | 5.6                | 158 | 0.7             |
| 12-02-12                 | 8                                                       | 13.3               | 168 | 0.8             |
| 12-04-72                 | 6                                                       | 7.3                | 170 | 1.5             |
| 12-07-72                 | 14                                                      | 9.5                | 161 | 1.0             |
| 12-11-72                 | 8                                                       | 9.2                | 185 | 1.0             |
| 01-16-73                 | 36                                                      | 7.8                | 176 | 1.2             |
| 01-23-73                 | 50                                                      | 1.6                | 20  | 1.2             |
| 01-25-73                 | 25                                                      | 10.3               | 187 | 0.8             |
| 02-07-73                 | 30                                                      | 7.0                | 81  | 1.2             |
| 03-07-73                 | 48                                                      | 5.9                | 130 | 1.7             |
| 03-08-73                 | 45                                                      | 4.3                | 118 | 1.4             |
| 03-12-73                 | 42                                                      | 4.2                | 128 | 1.1             |
| 03-23-73                 | 35                                                      | 4.4                | 122 | 1.6             |
| 04-06-73                 | 38                                                      | 5.1                | 125 | 1.2             |
| 04-18-73                 | 70                                                      | 3.1                | 33  | 2.0             |
| 04-26-73                 | 44                                                      | 4.4                | 77  | 2.3             |
| 05-01-73                 | 42                                                      | 2.8                | 113 | 1.4             |
| 05-04-73                 | 45                                                      | 4.1                | 85  | 1.8             |
| 05-08-73                 | 36                                                      | 3.9                | 72  | 1.3             |
| 05-09-73                 | 53                                                      | 3.5                | 64  | 1.2             |
| 05-10-73                 | 62                                                      | 2.9                | 43  | 1.0             |
| 05-11-73                 | 61                                                      | 3.3                | 74  | 2.0             |
| 05-15-73                 | 58                                                      | 4.1                | 70  | 1.7             |
| 05-16-73                 | 47                                                      | 4.1                | 60  | 1.5             |
| 05-17-73                 | 44                                                      | 3.8                | 71  | 1.5             |
| 05-18-73                 | 44                                                      | 4.5                | 96  | 1.5             |
| 05-22-73                 | 59                                                      | 3.5                | 56  | 1.7             |



TABLE 5 BASELINE EXHAUST EMISSIONS-1973 FORD TORINO

| Date<br>(month-day-year) | Initial engine coolant<br>temperature ( <sup>o</sup> F) | Emissions (g/mile) |    |                 |
|--------------------------|---------------------------------------------------------|--------------------|----|-----------------|
|                          |                                                         | HC                 | CO | NO <sub>x</sub> |
| 10-23-72                 | 78                                                      | 3.1                | 65 | 2.2             |
| 10-26-72                 | 70                                                      | 1.9                | 30 | 0.7             |
| 11-15-72                 | 73                                                      | 3.0                | 71 | 0.4             |
| 12-09-72                 | 76                                                      | 2.8                | 28 | 1.7             |
| 12-14-72                 | 75                                                      | 1.0                | 26 | 1.7             |
| 01-10-73                 | 76                                                      | 2.0                | 31 | 1.9             |
| 02-10-73                 | 69                                                      | 2.0                | 32 | 1.6             |
| 03-09-73                 | 74                                                      | 2.3                | 35 | 1.6             |
| 03-15-73                 | 75                                                      | 2.9                | 48 | 2.7             |
| 04-19-73                 | 77                                                      | 3.1                | 31 | 1.8             |
| 04-30-73                 | 72                                                      | 3.9                | 37 | 2.0             |
| 05-07-73                 | 73                                                      | 3.1                | 33 | 1.7             |
| 05-14-73                 | 68                                                      | 2.1                | 25 | 1.9             |

TABLE 6 COLD WEATHER EXHAUST EMISSIONS-1973 VEGA

| Date<br>(month-day-year) | Initial engine coolant<br>temperature ( $^{\circ}$ F) | Emissions (g/mile) |    |                 |
|--------------------------|-------------------------------------------------------|--------------------|----|-----------------|
|                          |                                                       | HC                 | CO | NO <sub>x</sub> |
| 11-10-72                 | 40                                                    | 1.8                | 36 | 1.0             |
| 11-11-72                 | 38                                                    | 2.3                | 45 | 1.5             |
| 11-17-72                 | 26                                                    | 2.6                | 46 | 1.4             |
| 11-22-72                 | 21                                                    | 4.7                | 16 | 1.9             |
| 12-01-72                 | 30                                                    | 1.3                | 40 | 1.7             |
| 12-02-72                 | 8                                                     | 4.0                | 20 | 2.2             |
| 12-05-72                 | 17                                                    | 3.3                | 53 | 1.1             |
| 12-07-72                 | 8                                                     | 6.6                | 45 | 1.8             |
| 12-12-72                 | 5                                                     | 3.4                | 51 | 1.5             |
| 12-14-72                 | 27                                                    | 2.3                | 26 | 1.5             |
| 12-21-72                 | 16                                                    | 3.2                | 54 | 1.6             |
| 01-06-73                 | 5                                                     | 3.9                | 62 | 1.4             |
| 01-08-73                 | -2                                                    | 5.1                | 63 | 1.4             |
| 01-10-73                 | 23                                                    | 2.8                | 34 | 1.3             |
| 01-12-73                 | -2                                                    | 5.5                | 63 | 1.6             |
| 01-17-73                 | 38                                                    | 2.0                | 43 | 1.0             |
| 01-19-73                 | 39                                                    | 2.2                | 40 | 1.9             |
| 01-25-73                 | 22                                                    | 2.8                | 53 | 1.3             |
| 01-26-73                 | 34                                                    | 1.3                | 39 | 1.7             |
| 01-30-73                 | 14                                                    | 3.2                | 57 | 1.7             |
| 02-03-73                 | 30                                                    | 2.2                | 41 | 1.8             |
| 02-05-73                 | 20                                                    | 3.3                | 47 | 1.8             |
| 02-10-73                 | 24                                                    | 4.4                | 54 | 2.8             |
| 01-13-73                 | -2                                                    | 4.3                | 62 | 1.1             |
| 03-21-73                 | 40                                                    | 2.2                | 33 | 1.4             |
| 03-23-73                 | 42                                                    | 2.7                | 39 | 1.6             |
| 03-29-73                 | 45                                                    | 2.7                | 37 | 1.8             |
| 04-18-73                 | 44                                                    | 3.0                | 37 | 1.2             |
| 04-24-73                 | 53                                                    | 2.7                | 39 | 2.1             |
| 04-25-73                 | 41                                                    | 2.7                | 38 | 1.7             |
| 04-27-73                 | 51                                                    | 2.6                | 38 | 1.6             |
| 05-02-73                 | 45                                                    | 4.4                | 29 | 1.6             |
| 05-03-73                 | 60                                                    | 3.1                | 33 | 1.8             |
| 05-04-73                 | 44                                                    | 2.8                | 39 | 1.7             |
| 05-08-73                 | 52                                                    | 2.3                | 42 | 1.5             |
| 05-09-73                 | 53                                                    | 2.8                | 38 | 1.5             |
| 05-10-73                 | 61                                                    | 2.4                | 34 | 1.0             |
| 05-11-73                 | 61                                                    | 2.2                | 33 | 0.9             |
| 05-15-73                 | 56                                                    | 2.9                | 31 | 2.1             |
| 05-18-73                 | 48                                                    | 2.7                | 34 | 1.3             |

TABLE 7 BASELINE EXHAUST EMISSIONS-1973 VEGA

| Date<br>(month-day-year) | Initial engine coolant<br>temperature ( <sup>o</sup> F) | Emissions (g/mile) |    |                 |
|--------------------------|---------------------------------------------------------|--------------------|----|-----------------|
|                          |                                                         | HC                 | CO | NO <sub>x</sub> |
| 10-26-72                 | 72                                                      | 1.3                | 17 | 1.3             |
| 11-20-72                 | 70                                                      | 2.6                | 48 | 2.1             |
| 12-08-72                 | 74                                                      | 2.3                | 33 | 2.1             |
| 12-09-72                 | 73                                                      | 1.7                | 29 | 1.7             |
| 12-19-72                 | 72                                                      | 1.4                | 32 | 1.5             |
| 01-09-73                 | 70                                                      | 2.3                | 31 | 1.2             |
| 01-15-73                 | 75                                                      | 2.2                | 49 | 1.5             |
| 01-22-73                 | 66                                                      | 1.6                | 37 | 1.2             |
| 02-02-73                 | 77                                                      | 1.8                | 30 | 1.3             |
| 02-12-73                 | 67                                                      | 1.7                | 32 | 2.0             |
| 02-14-73                 | 69                                                      | 2.7                | 34 | 1.8             |
| 02-15-73                 | 68                                                      | 1.7                | 33 | 1.6             |
| 02-17-73                 | 72                                                      | 2.4                | 45 | 1.9             |
| 02-19-73                 | 70                                                      | 1.8                | 36 | 1.6             |
| 02-21-73                 | 71                                                      | 2.6                | 45 | 1.9             |
| 03-20-73                 | 70                                                      | 1.2                | 24 | 2.1             |
| 04-19-73                 | 63                                                      | 2.2                | 24 | 2.0             |
| 04-26-73                 | 67                                                      | 2.5                | 21 | 2.0             |
| 05-07-73                 | 65                                                      | 2.5                | 33 | 1.9             |
| 05-14-73                 | 65                                                      | 2.2                | 28 | 1.4             |



TABLE 8 COLD WEATHER EXHAUST EMISSIONS-1973 PLYMOUTH SATELLITE

| Date<br>(month-day-year) | Initial engine coolant<br>temperature (°F) | Emissions (g/mile) |     |                 |
|--------------------------|--------------------------------------------|--------------------|-----|-----------------|
|                          |                                            | HC                 | CO  | NO <sub>x</sub> |
| 11-15-72                 | 32                                         | 5.1                | 125 | 3.4             |
| 11-21-72                 | 30                                         | 6.7                | 132 | 3.0             |
| 11-27-72                 | 40                                         | 5.5                | 121 | 1.6             |
| 12-02-72                 | 6                                          | 8.1                | 140 | 3.7             |
| 12-04-72                 | 6                                          | 8.0                | 131 | 3.3             |
| 12-06-72                 | 42                                         | 4.9                | 109 | 4.3             |
| 12-11-72                 | 5                                          | 6.5                | 155 | 4.4             |
| 12-13-72                 | 45                                         | 6.4                | 121 | 2.3             |
| 01-09-73                 | 16                                         | 9.4                | 155 | 3.1             |
| 01-11-73                 | 20                                         | 8.3                | 153 | 3.7             |
| 01-16-73                 | 36                                         | 6.1                | 130 | 1.8             |
| 01-18-73                 | 48                                         | 6.2                | 118 | 2.7             |
| 01-19-73                 | 45                                         | 5.4                | 116 | 2.4             |
| 02-06-73                 | 12                                         | 9.7                | 162 | 4.2             |
| 03-09-73                 | 35                                         | 6.6                | 111 | 4.1             |
| 03-13-73                 | 46                                         | 6.0                | 128 | 3.0             |
| 04-06-73                 | 38                                         | 8.7                | 140 | 2.0             |
| 04-18-73                 | 60                                         | 2.7                | 34  | 1.7             |
| 04-24-73                 | 36                                         | 4.4                | 97  | 2.1             |
| 04-25-73                 | 45                                         | 6.9                | 107 | 1.5             |
| 05-01-73                 | 45                                         | 4.8                | 150 | 2.1             |
| 05-08-73                 | 38                                         | 4.9                | 98  | 2.0             |
| 05-09-73                 | 53                                         | 4.0                | 76  | 2.0             |
| 05-10-73                 | 61                                         | 3.0                | 43  | 1.6             |
| 05-15-73                 | 54                                         | 3.7                | 75  | 1.7             |
| 05-16-73                 | 50                                         | 4.6                | 97  | 1.6             |
| 05-17-73                 | 45                                         | 6.3                | 102 | 2.1             |
| 05-18-73                 | 48                                         | 6.7                | 97  | 3.3             |
| 05-22-73                 | 60                                         | 2.8                | 28  | 2.9             |
| 05-29-73                 | 58                                         | 3.4                | 31  | 1.9             |
| 05-30-73                 | 62                                         | 2.9                | 30  | 1.8             |
| 05-31-73                 | 62                                         | 4.1                | 32  | 1.9             |
| 06-04-73                 | 60                                         | 3.1                | 40  | 1.7             |
| 06-05-73                 | 68                                         | 4.2                | 47  | 1.9             |
| 06-06-73                 | 57                                         | 3.3                | 28  | 1.8             |

TABLE 9 BASELINE EXHAUST EMISSIONS-1973 PLYMOUTH SATELLITE

| Date<br>(month-day-year) | Initial engine coolant<br>temperature ( <sup>o</sup> F) | Emissions (g/mile) |    |                 |
|--------------------------|---------------------------------------------------------|--------------------|----|-----------------|
|                          |                                                         | HC                 | CO | NO <sub>x</sub> |
| 10-30-72                 | 73                                                      | 2.1                | 27 | 1.5             |
| 11-17-72                 | 60                                                      | 2.3                | 25 | 2.6             |
| 11-28-72                 | 74                                                      | 2.7                | 40 | 2.2             |
| 12-07-72                 | 74                                                      | 2.8                | 25 | 2.8             |
| 01-12-73                 | 71                                                      | 2.5                | 30 | 2.1             |
| 01-13-73                 | 69                                                      | 2.4                | 30 | 2.1             |
| 01-23-73                 | 70                                                      | 2.0                | 23 | 1.7             |
| 02-05-73                 | 68                                                      | 2.2                | 21 | 2.5             |
| 02-17-73                 | 70                                                      | 2.2                | 31 | 2.8             |
| 03-07-73                 | 72                                                      | 2.3                | 31 | 2.8             |
| 03-08-73                 | 78                                                      | 2.9                | 43 | 2.0             |
| 03-12-73                 | 68                                                      | 2.4                | 27 | 2.6             |
| 03-14-73                 | 62                                                      | 2.3                | 25 | 2.4             |
| 03-22-73                 | 68                                                      | 2.8                | 56 | 2.2             |
| 03-27-73                 | 74                                                      | 1.7                | 9  | 1.6             |
| 03-29-73                 | 68                                                      | 2.7                | 22 | 1.7             |
| 04-19-73                 | 71                                                      | 2.0                | 19 | 1.9             |
| 04-28-73                 | 72                                                      | 2.9                | 31 | 2.2             |
| 04-30-73                 | 74                                                      | 2.4                | 31 | 2.5             |
| 05-07-73                 | 73                                                      | 2.7                | 22 | 2.0             |
| 05-14-73                 | 63                                                      | 2.0                | 22 | 1.5             |

TABLE 10 COLD WEATHER EXHAUST EMISSIONS-1972 CHEVROLET

| Date<br>(month-day-year) | Initial engine coolant<br>temperature ( $^{\circ}$ F) | Emissions (g/mile) |     |                 |
|--------------------------|-------------------------------------------------------|--------------------|-----|-----------------|
|                          |                                                       | HC                 | CO  | NO <sub>x</sub> |
| 11-08-72                 | 46                                                    | 2.8                | 48  | 3.0             |
| 11-13-72                 | 44                                                    | 3.1                | 63  | 1.9             |
| 11-14-72                 | 27                                                    | 3.1                | 78  | 3.8             |
| 11-20-72                 | 34                                                    | 3.7                | 83  | 3.0             |
| 11-22-72                 | 20                                                    | 6.0                | 120 | 2.3             |
| 12-06-72                 | 45                                                    | 2.9                | 49  | 2.4             |
| 12-08-72                 | 16                                                    | 4.5                | 82  | 2.2             |
| 12-19-72                 | 12                                                    | 3.8                | 96  | 3.2             |
| 01-06-73                 | 3                                                     | 6.7                | 115 | 2.5             |
| 01-09-73                 | 14                                                    | 5.4                | 121 | 2.3             |
| 01-11-73                 | 30                                                    | 4.7                | 111 | 3.2             |
| 01-15-73                 | 33                                                    | 3.9                | 87  | 2.2             |
| 01-18-73                 | 44                                                    | 3.3                | 77  | 2.1             |
| 01-22-73                 | 15                                                    | 4.5                | 103 | 0.8             |
| 01-24-73                 | 28                                                    | 4.5                | 108 | 2.6             |
| 02-05-73                 | 22                                                    | 4.5                | 101 | 2.9             |
| 02-08-73                 | 24                                                    | 4.1                | 87  | 2.9             |
| 02-21-73                 | 25                                                    | 3.7                | 93  | 3.0             |
| 03-08-73                 | 47                                                    | 3.2                | 71  | 3.2             |
| 03-14-73                 | 42                                                    | 2.2                | 53  | 3.1             |
| 04-24-73                 | 47                                                    | 3.1                | 79  | 3.3             |
| 04-27-73                 | 53                                                    | 3.0                | 73  | 3.4             |
| 05-25-73                 | 50                                                    | 3.8                | 86  | 2.8             |
| 05-28-73                 | 57                                                    | 4.0                | 50  | 2.6             |
| 05-29-73                 | 60                                                    | 3.0                | 43  | 2.5             |
| 05-30-73                 | 62                                                    | 2.2                | 43  | 2.6             |
| 05-31-73                 | 51                                                    | 2.5                | 44  | 2.6             |
| 06-04-73                 | 62                                                    | 3.7                | 56  | 2.4             |
| 06-05-73                 | 65                                                    | 2.6                | 41  | 2.7             |
| 06-06-73                 | 71                                                    | 2.8                | 40  | 2.6             |



TABLE 11 BASELINE EXHAUST EMISSIONS-1972 CHEVROLET

| Date<br>(month-day-year) | Initial engine coolant<br>temperature ( <sup>o</sup> F) | Emissions (g/mile) |    |                 |
|--------------------------|---------------------------------------------------------|--------------------|----|-----------------|
|                          |                                                         | HC                 | CO | NO <sub>x</sub> |
| 11-09-72                 | 72                                                      | 1.6                | 25 | 2.3             |
| 12-05-72                 | 72                                                      | 2.2                | 46 | 2.1             |
| 12-09-72                 | 77                                                      | 2.8                | 31 | 3.3             |
| 12-11-72                 | 76                                                      | 2.3                | 28 | 4.3             |
| 12-13-72                 | 76                                                      | 2.5                | 44 | 2.1             |
| 12-20-72                 | 75                                                      | 3.0                | 55 | 2.6             |
| 01-16-73                 | 74                                                      | 2.6                | 42 | 1.9             |
| 01-25-73                 | 66                                                      | 2.3                | 40 | 3.2             |
| 02-06-73                 | 69                                                      | 2.7                | 53 | 3.0             |
| 02-09-73                 | 72                                                      | 2.6                | 47 | 3.2             |
| 03-09-73                 | 72                                                      | 1.9                | 39 | 3.1             |
| 03-13-73                 | 75                                                      | 2.2                | 39 | 3.5             |
| 04-26-73                 | 64                                                      | 2.6                | 37 | 4.4             |
| 04-30-73                 | 71                                                      | 2.5                | 34 | 5.0             |
| 06-08-73                 | 76                                                      | 3.2                | 22 | 2.8             |

TABLE 12 BLOCK HEATER TEST EMISSIONS

| Vehicle<br>make | Ambient<br>test<br>temperature<br>(°F) | Engine<br>coolant<br>temperature<br>at start-up<br>time (°F) | Emissions (g/mile) |       |                 | Test date<br>(month-day-year) |
|-----------------|----------------------------------------|--------------------------------------------------------------|--------------------|-------|-----------------|-------------------------------|
|                 |                                        |                                                              | HC                 | CO    | NO <sub>x</sub> |                               |
| 1973 Vega       | 29                                     | 90                                                           | 1.58               | 28.81 | 1.73            | 02-22-73                      |
|                 | 18                                     | 60                                                           | 2.43               | 31.90 | 1.72            | 02-26-73                      |
|                 | 8                                      | 55                                                           | 2.68               | 31.20 | 1.92            | 02-27-73                      |
|                 | 19                                     | 90                                                           | 2.29               | 21.62 | 2.08            | 02-28-73                      |
|                 | 25                                     | N/A                                                          | 2.03               | 21.25 | 2.56            | 03-01-73                      |
| 1972 Chevrolet  | 26                                     | 110                                                          | 1.86               | 20.97 | 3.83            | 02-07-73                      |
|                 | 34                                     | 106                                                          | 1.99               | 16.11 | 2.77            | 02-20-73                      |
|                 | 24                                     | 105                                                          | 1.84               | 27.47 | 2.51            | 02-22-73                      |
|                 | 14                                     | 95                                                           | 2.27               | 52.66 | 2.77            | 02-23-73                      |
|                 | 9                                      | 80                                                           | 2.47               | 49.91 | 2.88            | 02-26-73                      |
|                 | 26                                     | 125                                                          | 2.35               | 31.27 | 3.57            | 03-02-73                      |

TABLE 13 IDLE TEST EMISSIONS-1973 TORINO

| Date<br>(month-day-year) | Idle<br>time (min) | Idle<br>emissions (g) |        | 23-min<br>test emissions (g) |       |                 | Total<br>emissions (g) |        | Ambient<br>test<br>temperature<br>(°F) |
|--------------------------|--------------------|-----------------------|--------|------------------------------|-------|-----------------|------------------------|--------|----------------------------------------|
|                          |                    | HC                    | CO     | HC                           | CO    | NO <sub>x</sub> | HC                     | CO     |                                        |
| 02-20-73                 | 2                  | 14.5                  | 435.1  | 22.9                         | 508.1 | 9.4             | 37.4                   | 943.2  | 41                                     |
| 02-21-73                 | 5                  | 67.2                  | 1714.7 | 12.7                         | 114.0 | 8.8             | 79.9                   | 1828.7 | 23                                     |
| 02-22-73                 | 15                 | 67.1                  | 2484.3 | 10.2                         | 87.3  | 8.7             | 77.3                   | 2571.6 | 23                                     |
| 02-23-73                 | 2                  | 46.8                  | 469.0  | 34.7                         | 967.1 | 8.7             | 81.5                   | 1436.1 | 15                                     |
| 02-26-73                 | 5                  | 141.3                 | 1701.8 | 11.5                         | 144.3 | 10.6            | 152.8                  | 1846.1 | 12                                     |
| 02-27-73                 | 15                 | 122.4                 | 1696.1 | 10.5                         | 106.0 | 11.5            | 132.9                  | 1802.1 | 3                                      |
| 02-28-73                 | 2                  | 51.0                  | 508.6  | 35.9                         | 950.0 | 8.6             | 86.9                   | 1458.9 | 8                                      |
| 03-01-73                 | 5                  | 62.0                  | 1668.2 | 12.2                         | 125.1 | 10.7            | 74.2                   | 1793.3 | 29                                     |
| 03-02-73                 | 15                 | 61.3                  | 1394.3 | 10.4                         | 28.2  | 8.9             | 71.7                   | 1422.5 | 27                                     |



TABLE 14 IDLE TEST EMISSIONS-1973 SATELLITE

| Date<br>(month-day-year) | Idle<br>time(min) | Idle<br>emissions (g) |        | 23-min<br>test emissions (g) |       |                 | Total<br>emissions (g) |        | Ambient<br>test<br>temperature<br>(°F) |
|--------------------------|-------------------|-----------------------|--------|------------------------------|-------|-----------------|------------------------|--------|----------------------------------------|
|                          |                   | HC                    | CO     | HC                           | CO    | NO <sub>x</sub> | HC                     | CO     |                                        |
| 02-20-73                 | 2                 | 66.0                  | 310.8  | 72.8                         | 886.4 | 24.9            | 138.8                  | 1197.2 | 39                                     |
| 02-21-73                 | 5                 | 154.3                 | 1039.5 | 28.7                         | 492.2 | 45.4            | 183.0                  | 1531.7 | 22                                     |
| 03-06-73                 | 15                | 245.3                 | 1891.5 | 11.6                         | 70.8  | 21.7            | 256.9                  | 1962.3 | 34                                     |
| 03-05-73                 | 2                 | 114.7                 | 1136.4 | 37.0                         | 428.9 | 28.4            | 151.7                  | 1565.3 | 39                                     |
| 02-26-73                 | 5                 | 200.9                 | 1239.3 | 27.2                         | 312.3 | 45.2            | 228.1                  | 1551.6 | 14                                     |
| 02-27-73                 | 15                | 187.7                 | 1468.2 | 20.3                         | 84.6  | 46.0            | 208.0                  | 1552.8 | 0                                      |
| 02-28-73                 | 2                 | 80.1                  | 420.0  | 53.5                         | 864.4 | 38.9            | 133.6                  | 1284.4 | 9                                      |
| 03-01-73                 | 5                 | 188.3                 | 973.5  | 29.3                         | 514.6 | 48.3            | 217.6                  | 1488.1 | 29                                     |
| 03-02-73                 | 15                | 162.2                 | 1551.5 | 18.5                         | 23.3  | 37.1            | 180.7                  | 1574.8 | 28                                     |

TABLE 15 IDLE TEST EMISSIONS-1973 VEGA

| Date<br>(month-day-year) | Idle<br>time (min) | Idle<br>emissions (g) |       | 23-min<br>test emissions (g) |       |                 | Total<br>emissions (g) |       | Ambient<br>test<br>temperature<br>(°F) |
|--------------------------|--------------------|-----------------------|-------|------------------------------|-------|-----------------|------------------------|-------|----------------------------------------|
|                          |                    | HC                    | CO    | HC                           | CO    | NO <sub>x</sub> | HC                     | CO    |                                        |
| 03-08-73                 | 2                  | 11.3                  | 201.2 | 16.4                         | 120.8 | 19.9            | 27.7                   | 322.0 | 52                                     |
| 03-09-73                 | 5                  | 14.7                  | 337.3 | 10.9                         | 32.9  | 18.8            | 25.6                   | 370.2 | 36                                     |
| 03-07-73                 | 15                 | 40.8                  | 327.5 | 12.1                         | 48.7  | 14.9            | 52.9                   | 376.2 | 47                                     |
| 03-27-73                 | 2                  | 12.2                  | 250.1 | 17.6                         | 141.8 | 11.2            | 29.8                   | 391.9 | 46                                     |
| 03-28-73                 | 5                  | 26.3                  | 152.4 | 12.0                         | 120.0 | 12.8            | 38.3                   | 272.4 | 58                                     |
| 03-12-73                 | 15                 | 10.4                  | 171.8 | 14.7                         | 120.9 | 15.2            | 25.1                   | 292.7 | 49                                     |
| 03-28-73                 | 2                  | 4.1                   | 163.2 | 16.7                         | 131.4 | 12.2            | 20.8                   | 294.6 | 43                                     |
| 04-03-73                 | 5                  | 10.4                  | 302.0 | 16.3                         | 81.6  | 11.7            | 26.7                   | 383.6 | 40                                     |
| 03-15-73                 | 15                 | 16.4                  | 465.6 | 10.1                         | 112.3 | 16.0            | 26.5                   | 577.9 | 42                                     |

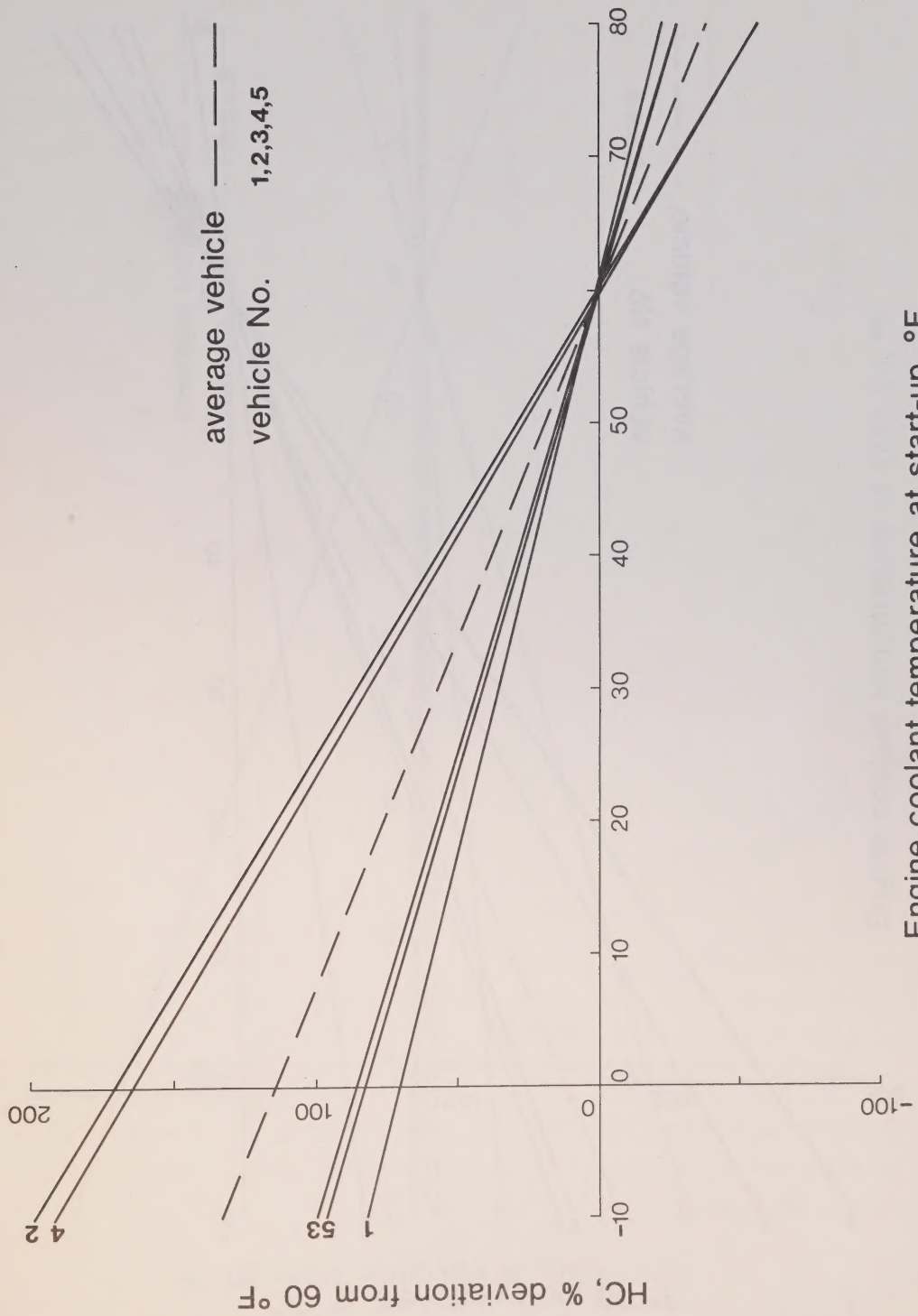


FIGURE 1 HC EMISSIONS AS A FUNCTION OF TEMPERATURE



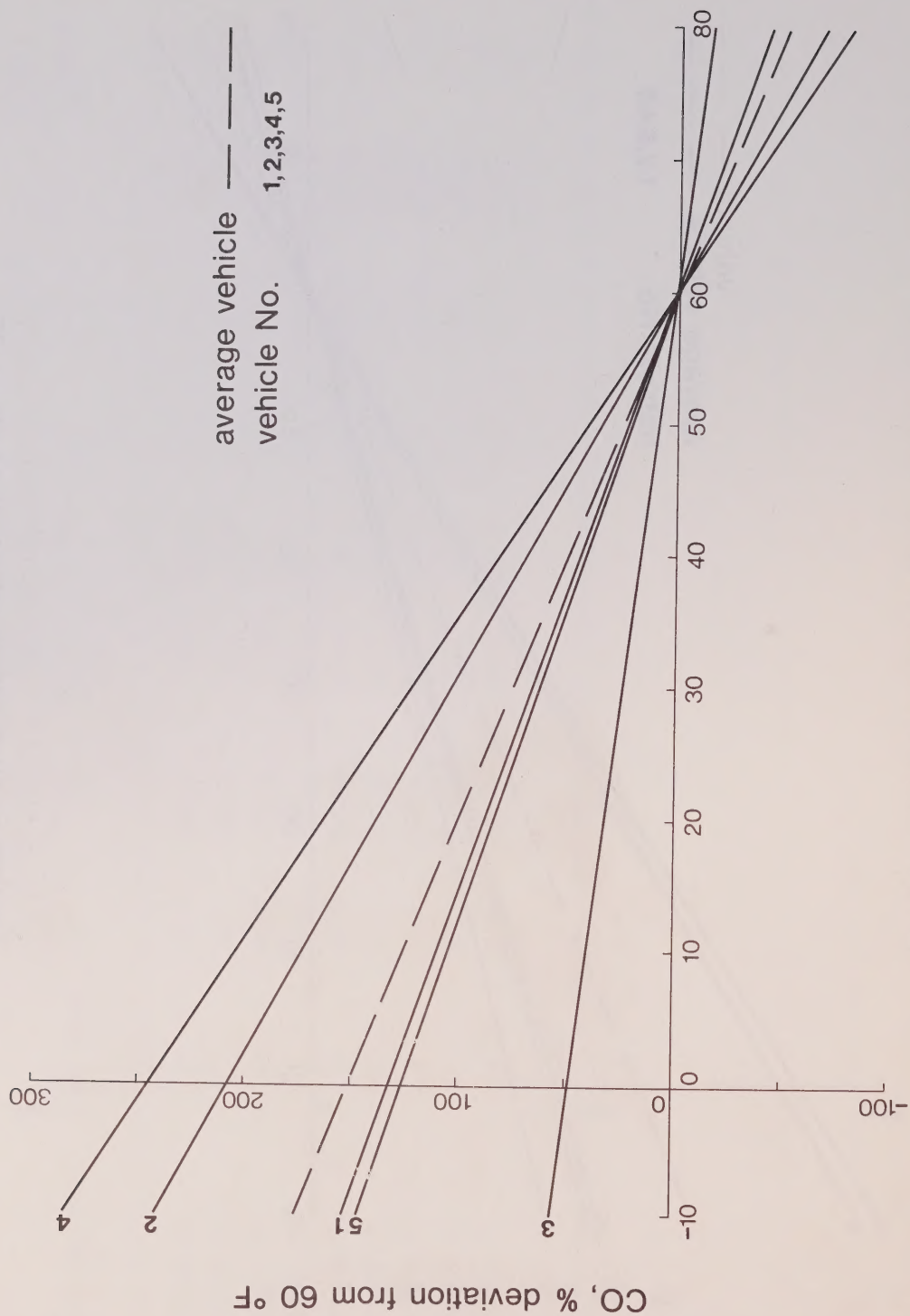
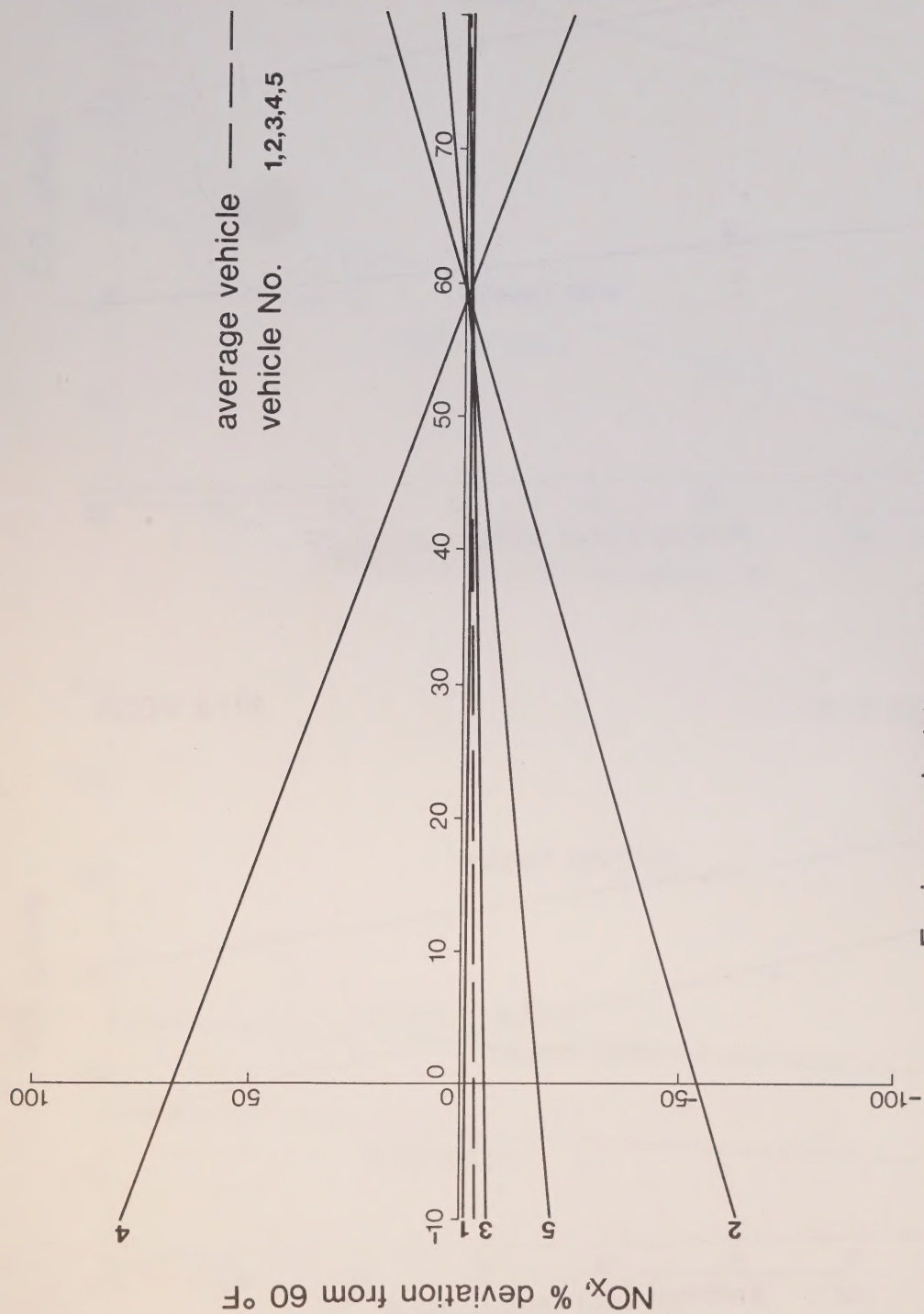


FIGURE 2 CO EMISSIONS AS A FUNCTION OF TEMPERATURE



Engine coolant temperature at start-up, °F

FIGURE 3 NO<sub>x</sub> EMISSIONS AS A FUNCTION OF TEMPERATURE

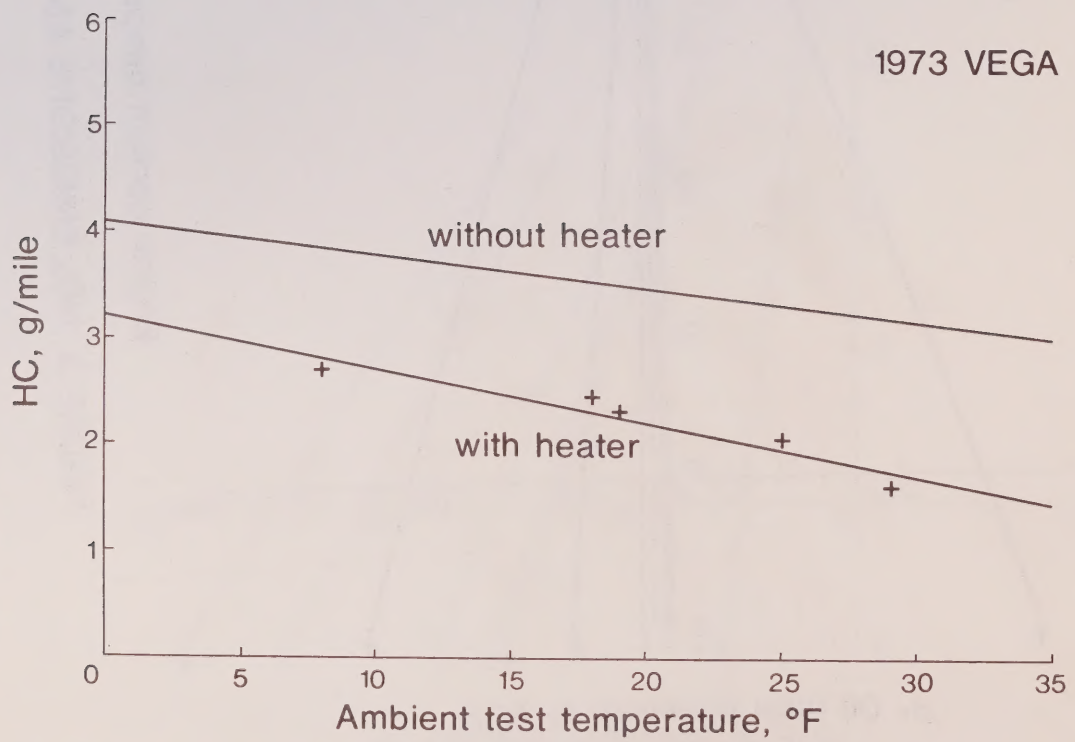
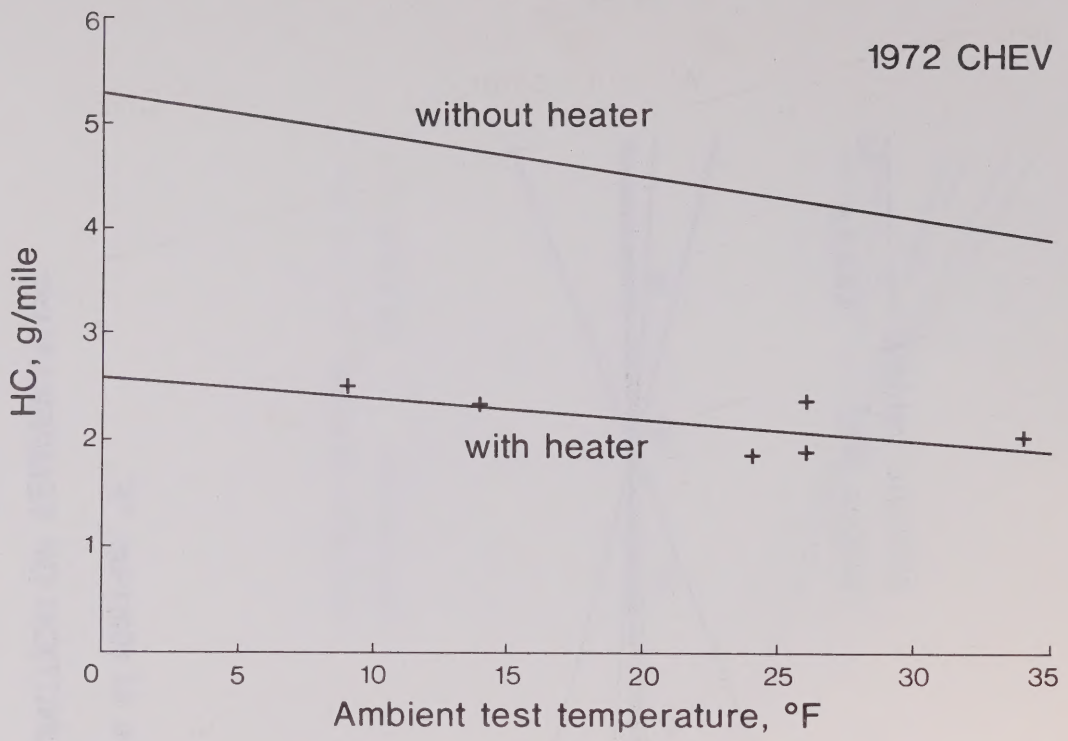


FIGURE 4 EFFECT OF HEATER ON HC EMISSIONS VERSUS TEMPERATURE CURVE



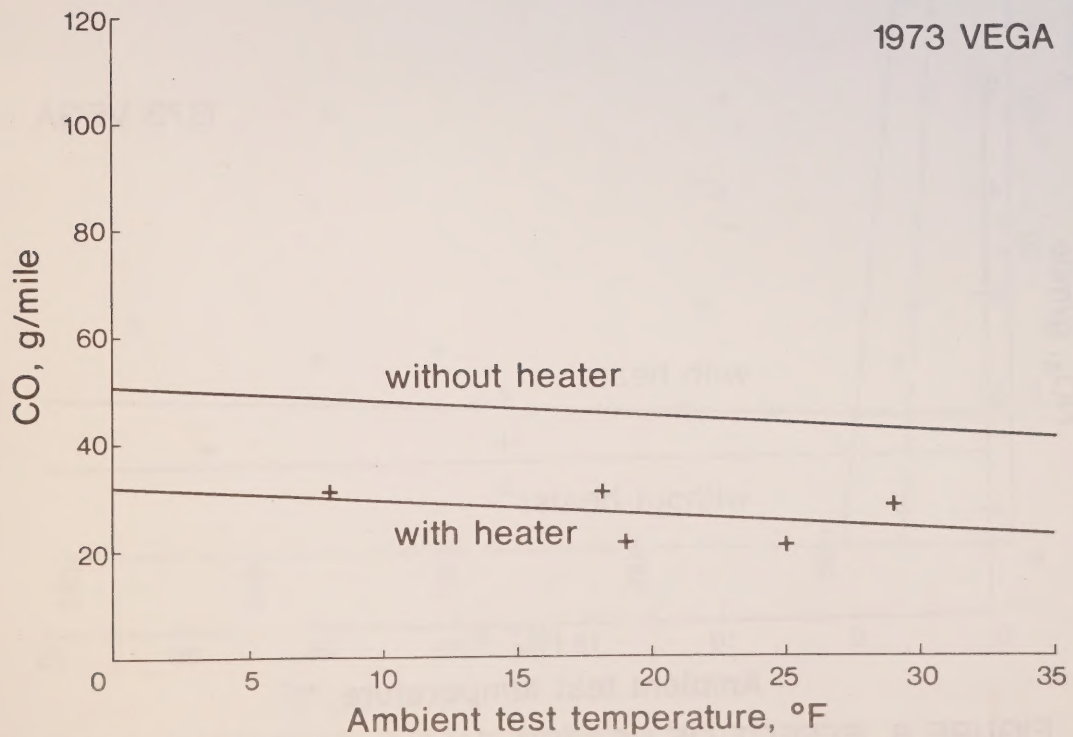
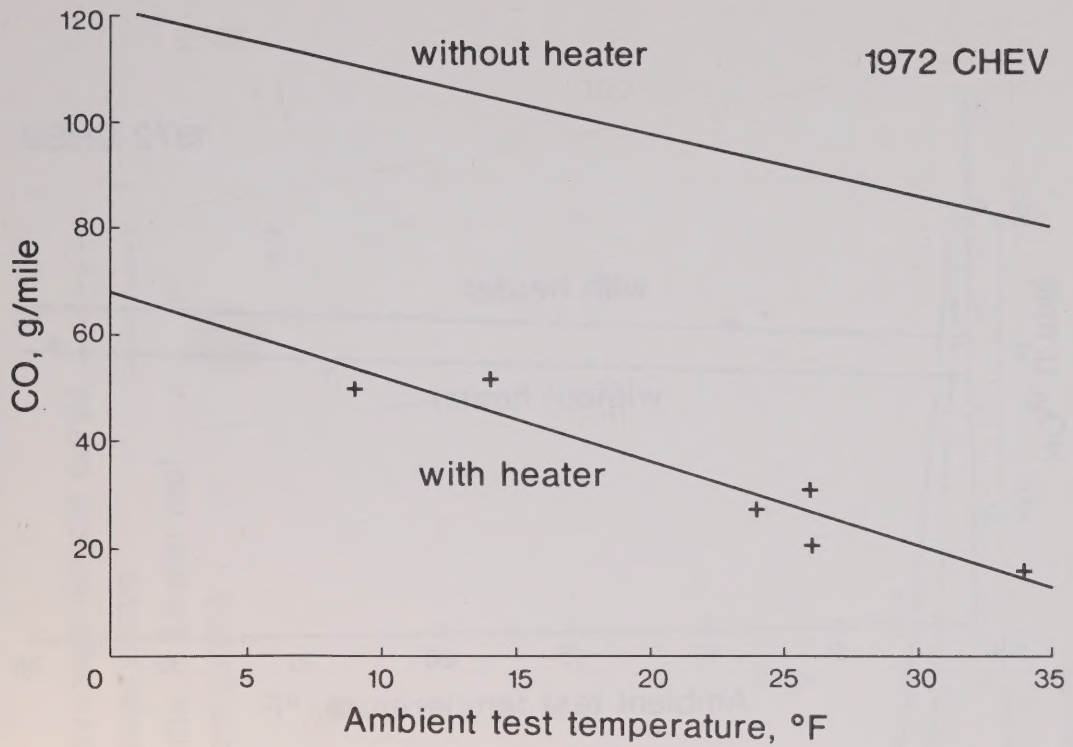


FIGURE 5 EFFECT OF HEATER ON CO EMISSIONS VERSUS TEMPERATURE CURVE

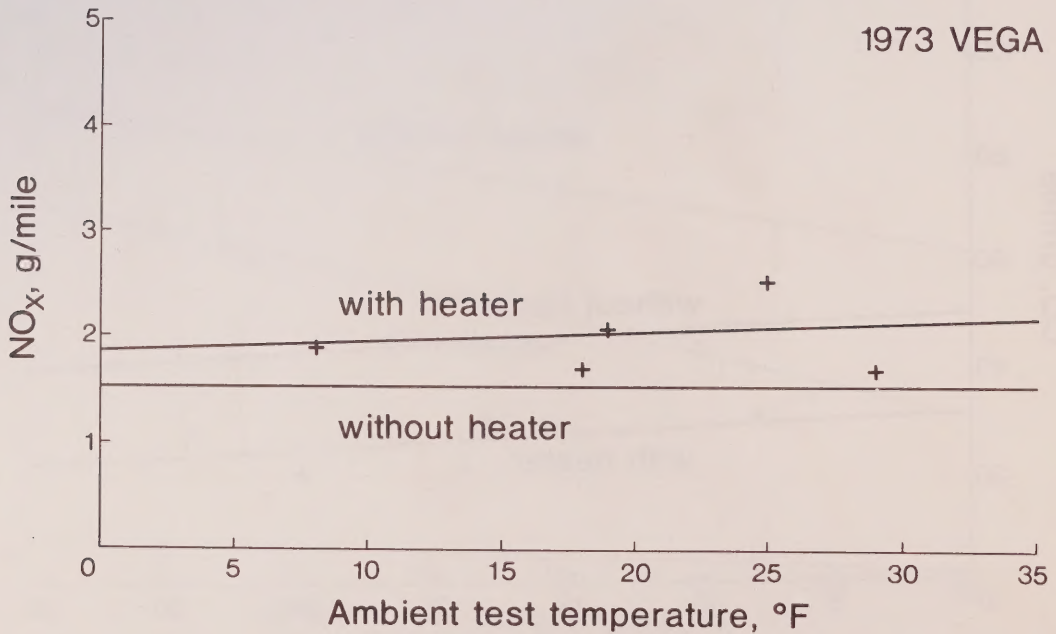
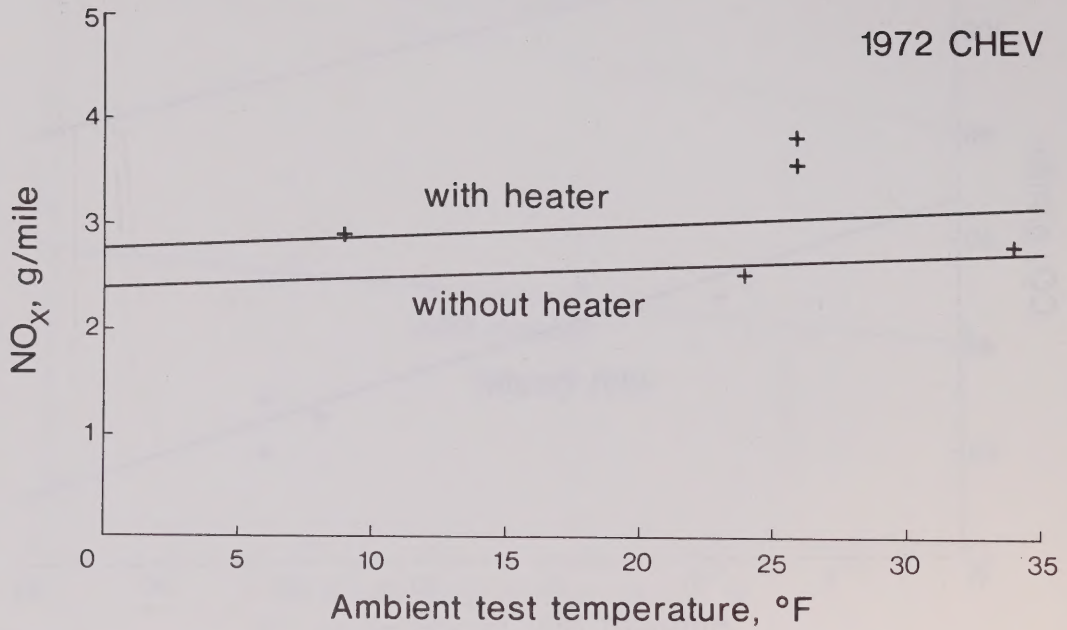


FIGURE 6 EFFECT OF HEATER ON NO<sub>x</sub> EMISSIONS VERSUS TEMPERATURE CURVE

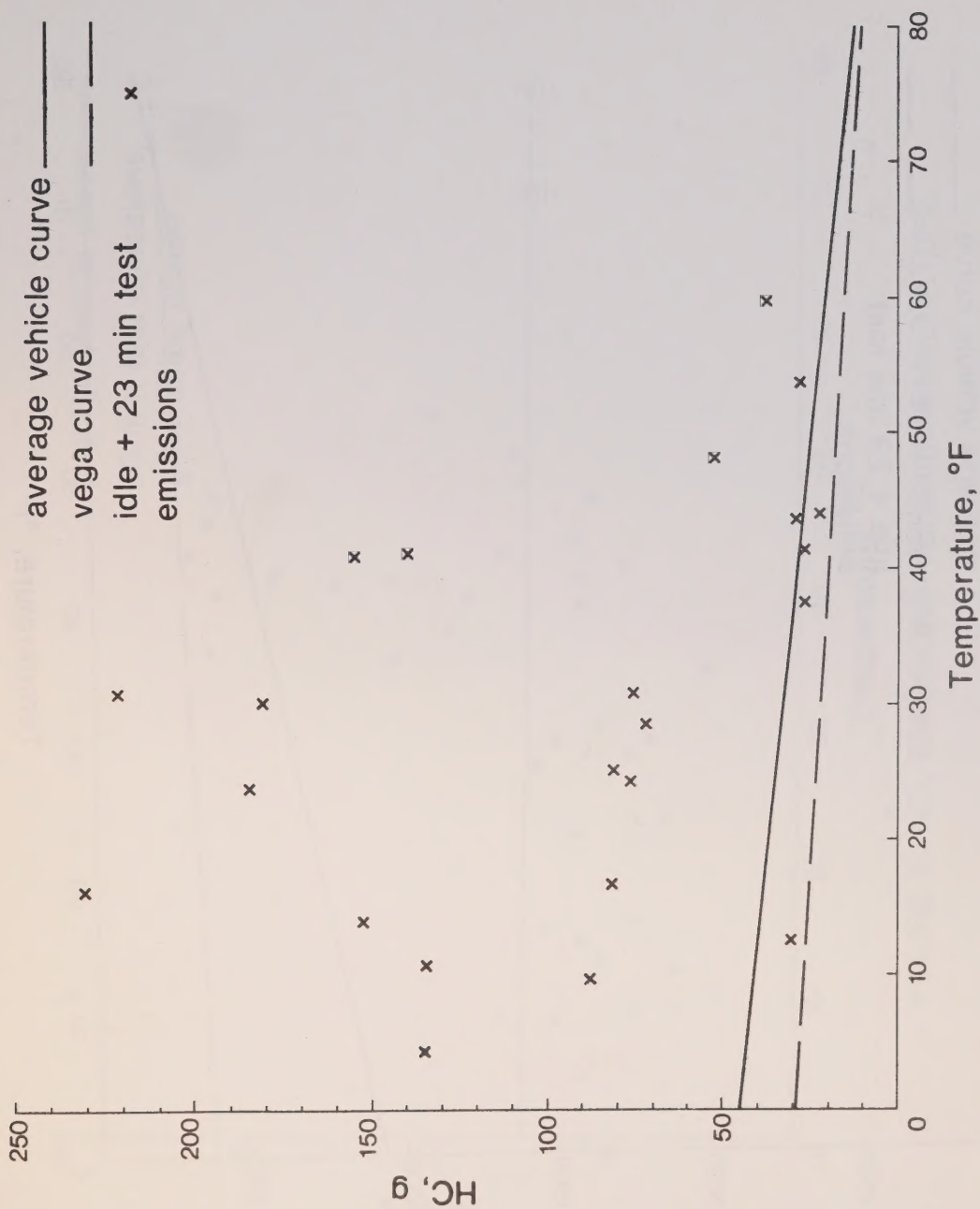


FIGURE 7 TOTAL HC EMISSIONS VERSUS TEMPERATURE



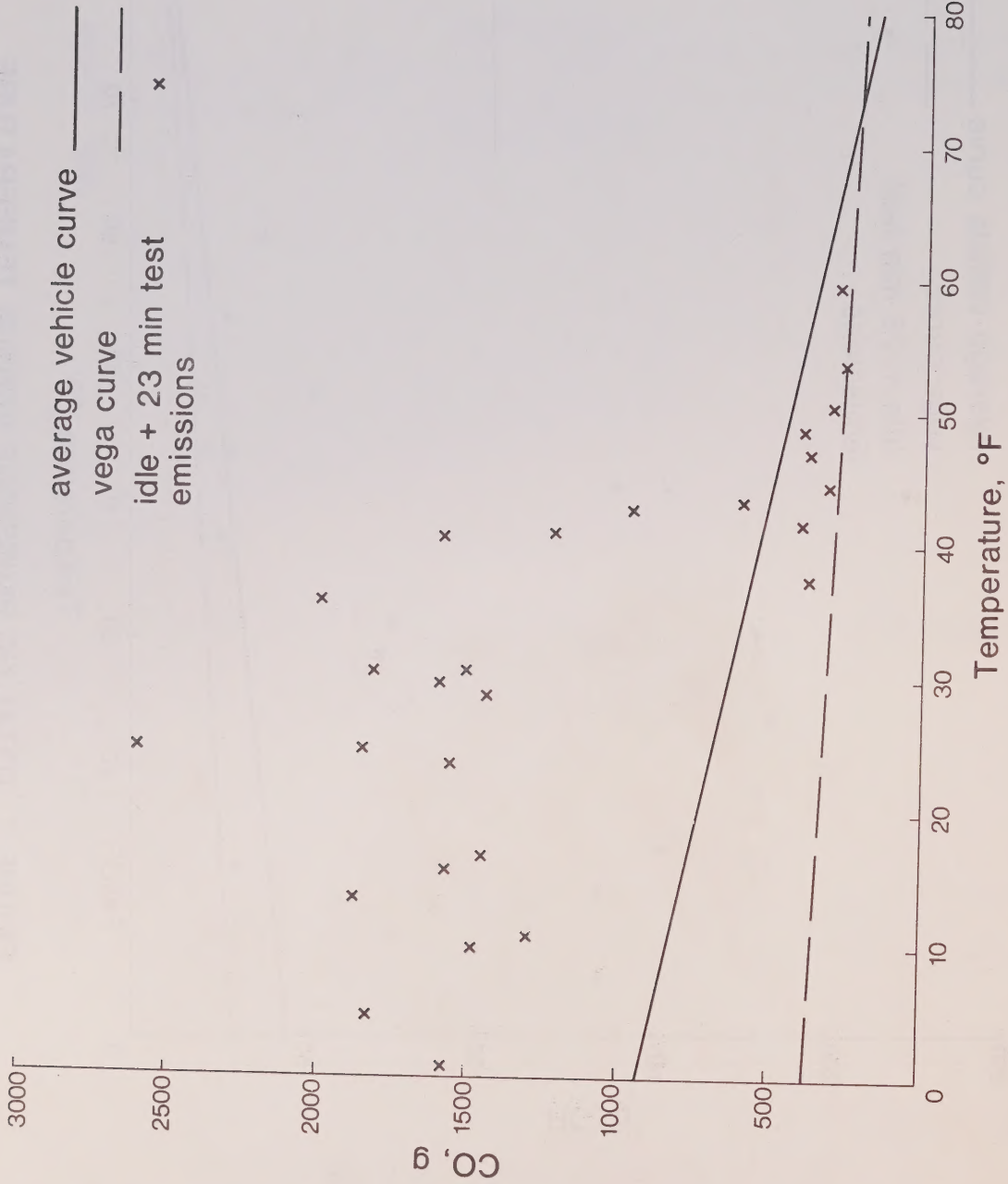


FIGURE 8 TOTAL CO EMISSIONS VERSUS TEMPERATURE

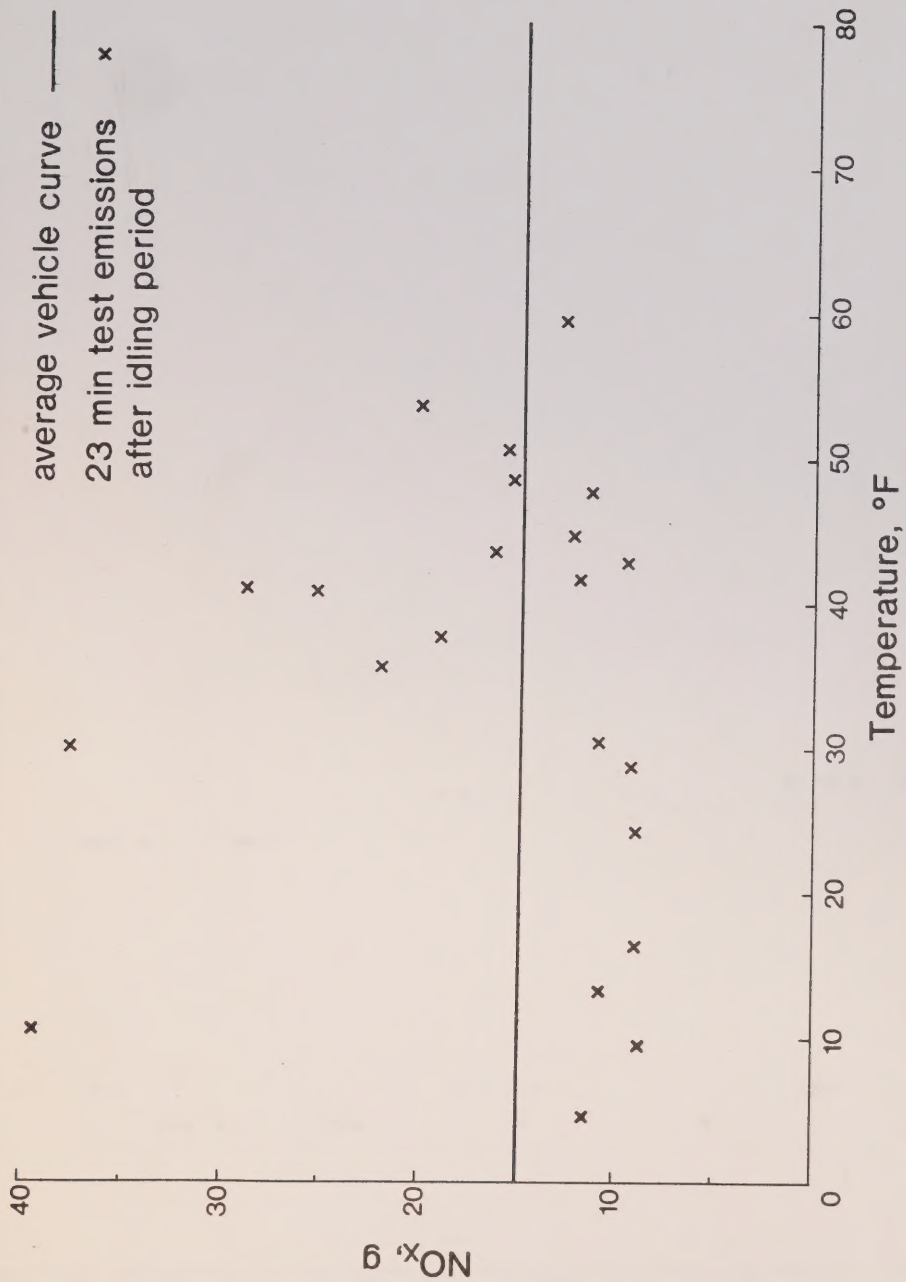


FIGURE 9 NO<sub>x</sub> EMISSIONS VERSUS TEMPERATURE

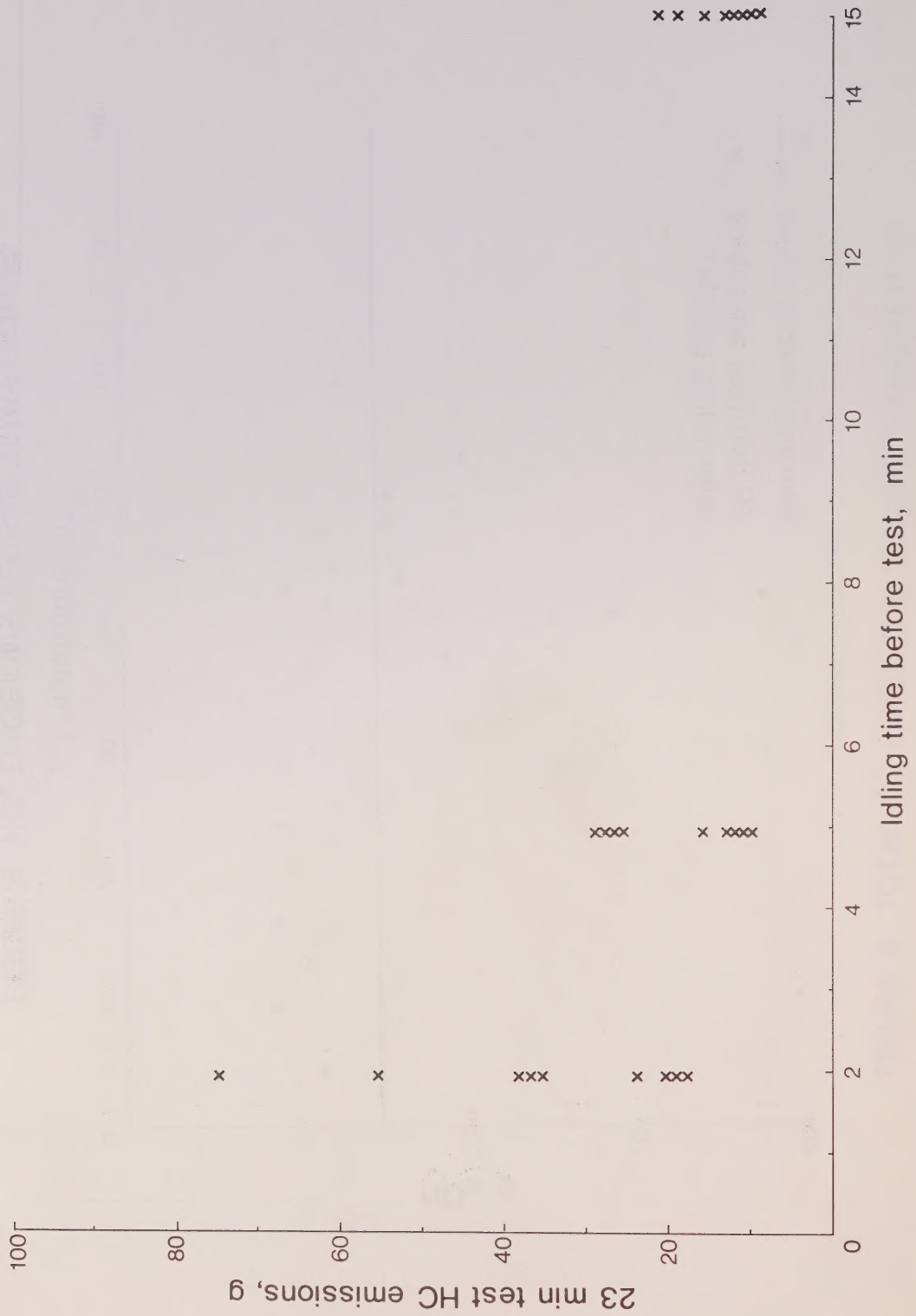


FIGURE 10 TEST HC EMISSIONS VERSUS IDLING TIME

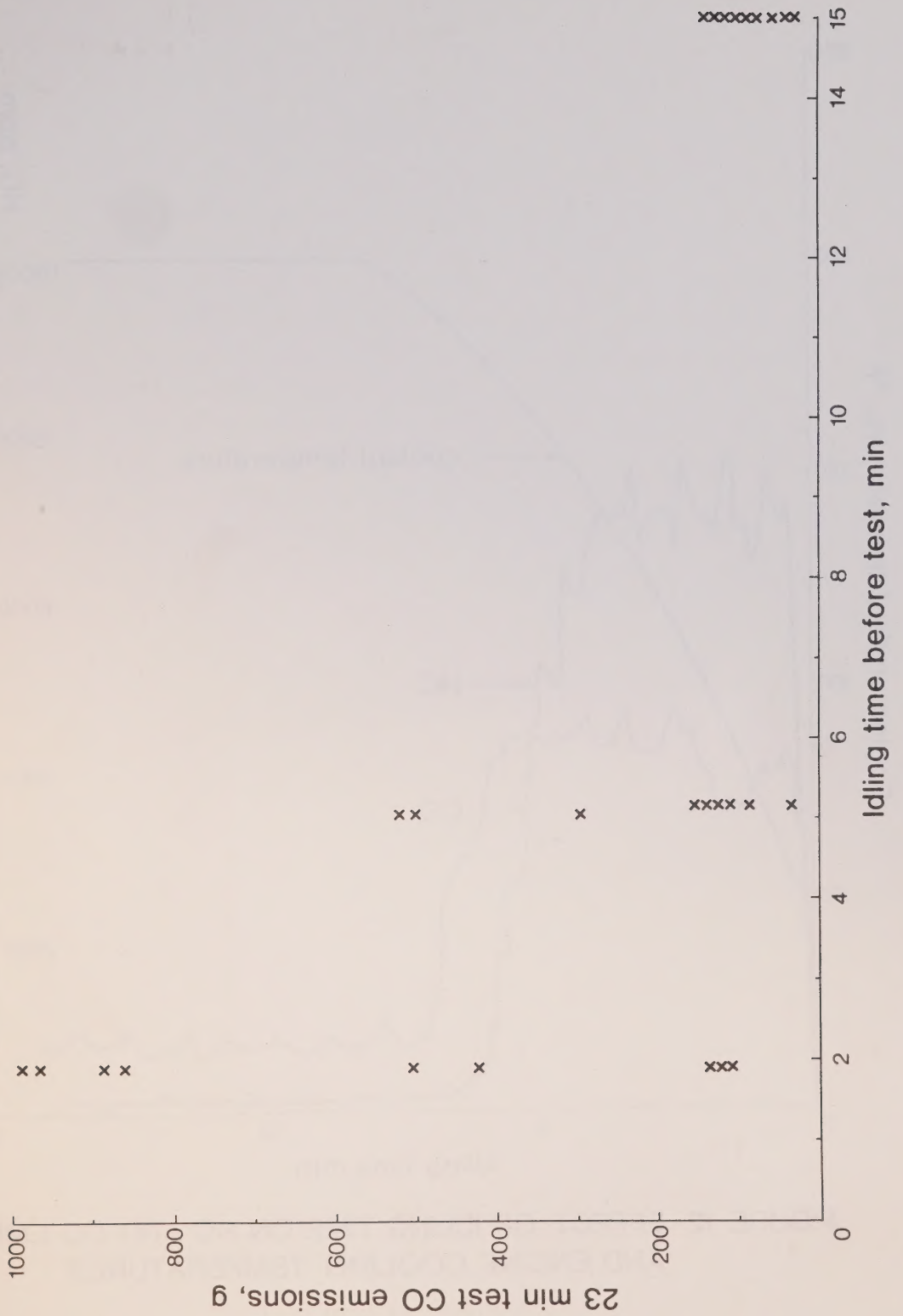


FIGURE 11 TEST CO EMISSIONS VERSUS IDLING TIME



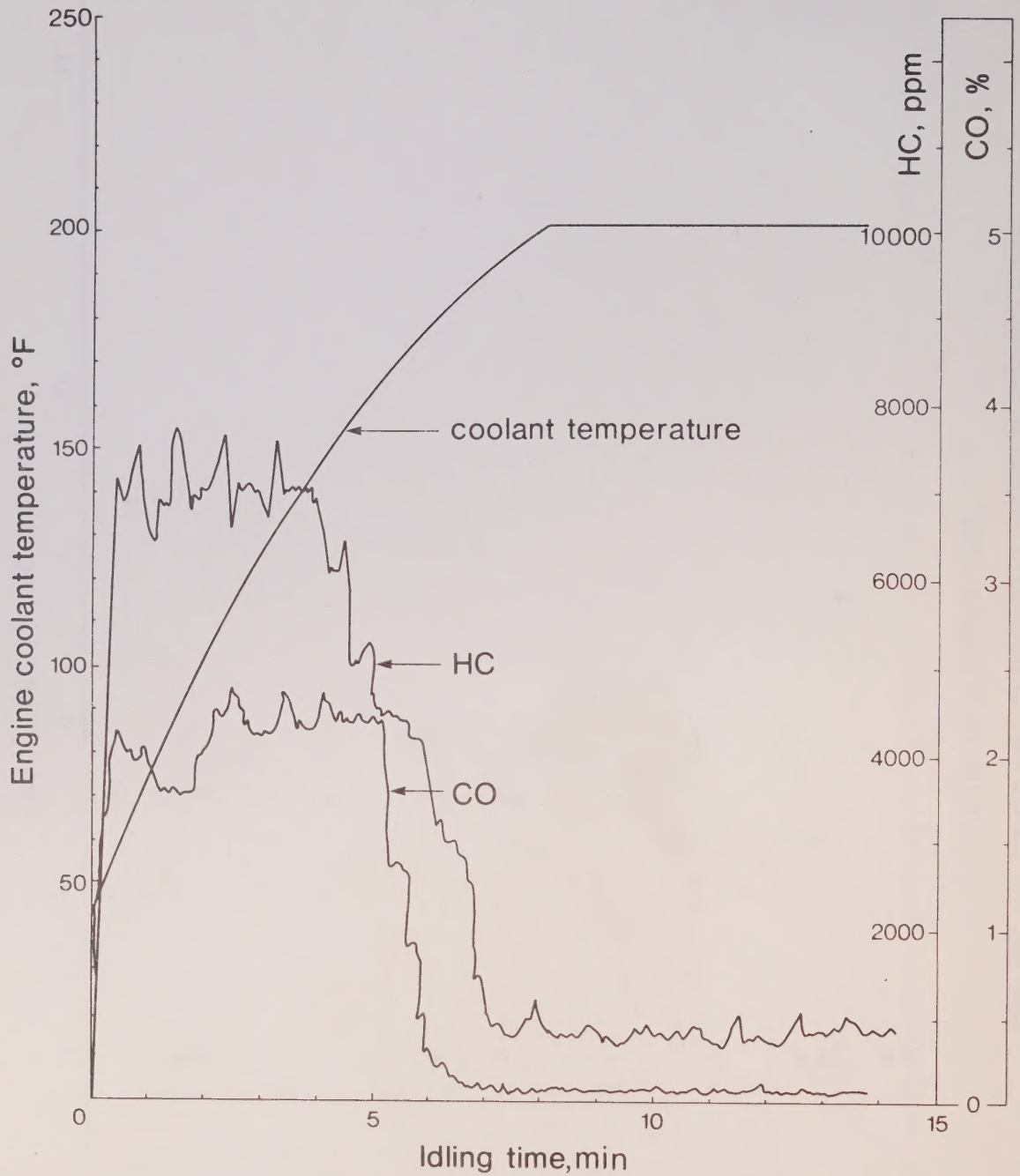


FIGURE 12 EFFECT OF IDLING TIME ON HC AND CO EMISSIONS AND ENGINE COOLANT TEMPERATURES





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